

CHICAGO FORECAST DISTRICT.

A cold wave appeared in the extreme Northwest on the morning of the 12th, which gradually extended, with increasing intensity over the entire district. Its force was broken in the extreme Northwest on the 20th and over the eastern and central portions of the district on the 21st and 22d. For long duration and low temperature it was the most remarkable cold wave that has prevailed in the district so early in the winter season for twenty-five years. The shipment of perishable goods was at a standstill. Warnings were issued well in advance, almost without exception, throughout all portions of the forecast district, and the benefits derived from the information were undoubtedly very great. The most severe storm of the month on the upper lakes accompanied the approach of this cold wave during the 13th and 14th. Considering the severity of the storm, comparatively few wrecks were reported and it is thought that most of the vessels sought shelter as soon as the warnings were observed.

On the night of the 21st the car ferry *Muskegon* was wrecked in making the entrance to the harbor at Ludington, Mich., while high southwest wind was prevailing. Warnings for high winds had been sent to the west shore of the lake before the departure of the *Muskegon*, but car ferries of this character, as a rule, make trips across the lake in the most severe storms, and generally find no difficulty in making a passage in a storm of ordinary character, such as the one of the 21st and 22d.—*H. J. Cox, Professor.*

NEW ORLEANS FORECAST DISTRICT.

Severe weather conditions occurred over this district in December. Very well-marked cold waves crossed the district during the month, for which warnings were issued, as a rule, forty-eight hours in advance of the occurrence of verifying temperatures. Special temperature warnings were issued for the benefit of the sugar planters. The warnings were of great value.—*I. M. Cline, Forecast Official.*

DENVER FORECAST DISTRICT.

The month was characterized by mild weather. This temperature condition so favorable to live stock interests was interrupted, however, on the 11th and 12th, when a cold wave extended over the district. Special warnings of snow and cold weather were sent to live stock and railroad interests, and warnings of freezing temperature were telegraphed to points in Arizona. Live stock interests sustained no material loss.—*F. H. Brandenburg, Forecast Official.*

PORTLAND, OREG., FORECAST DISTRICT.

Two storms of great severity crossed the district during December. Both were successfully forecast, and warnings were sent to all seaports eight to twelve hours before the high winds began. Several lives were lost and many shipwrecks and other casualties occurred during the gales. The ship disasters were confined almost exclusively to the inward bound fleet, and, so far as known, no seagoing vessels left port after warnings were issued.—*Edward A. Beals, Forecast Official.*

HAVANA, CUBA, FORECAST DISTRICT.

On December 14 a warning of strong northwest winds and lower temperature was received from Washington and

disseminated throughout the island; the forecast was amply verified. Conditions did not warrant the issue of warnings or advices at any other time during the month.—*W. B. Stockman, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1, a.m.	53	108	2, a.m.	41	97	1,000	2.0	500	30.8
II.....	2, a.m.	50	100	7, p.m.	48	69	1,700	5.5	309	12.9
III.....	4, a.m.	37	123	8, p.m.	34	78	2,000	6.5	308	12.8
IV.....	6, a.m.	35	121	9, a.m.	39	108	1,000	1.0	1,000	41.7
V.....	11, p.m.	51	120	14, a.m.	47	54	5,525	8.0	690	28.8
VI.....	15, a.m.	47	122	20, p.m.	46	69	3,650	6.0	608	25.3
VII.....	18, p.m.	51	104	23, a.m.	32	65	3,925	4.6	872	32.6
VIII.....	25, a.m.	37	100	27, a.m.	46	60	3,200	2.0	1,600	66.7
IX.....	25, a.m.	43	123	28, p.m.	46	60	4,000	3.5	1,143	47.6
X.....	27, a.m.	43	123	30, a.m.	39	108	1,100	3.0	367	15.3
XI.....	30, a.m.	54	114	2, p.m.*	32	81	2,750	3.5	786	32.8
Sums.....							34,150	51.0	8,965	373.6
Mean of 13 paths.....							2,646		747	31.1
Mean of 51.0 days.....									670	27.9
Low areas.										
I.....	3, p.m.	48	125	5, a.m.	47	104	1,300	1.5	867	36.1
II.....	5, a.m.	43	123	7, a.m.	47	89	1,900	2.0	950	39.6
III.....	6, a.m.	33	115	9, a.m.	45	74	3,050	3.0	1,017	42.8
IV.....	7, p.m.	54	114	10, a.m.	48	68	3,800	4.5	844	35.2
V.....	11, a.m.	33	115	9, a.m.	46	96	1,050	1.5	700	29.2
VI.....	12, a.m.	50	97	16, p.m.	46	60	3,850	5.5	700	29.2
VII.....	21, a.m.	53	105	26, a.m.	47	54	2,800	4.5	622	25.9
VIII.....	23, p.m.	44	104	25, a.m.	42	76	3,000	5.0	600	25.0
VIII.....	26, a.m.	47	89	27, p.m.	46	60	1,950	1.5	1,300	54.2
IX.....	27, p.m.	29	95	31, a.m.	47	54	2,600	3.5	743	31.0
Sums.....							27,100	34.0	9,548	397.7
Mean of 11 paths.....							2,464		867	36.2
Mean of 34.0 days.....									797	33.2

*January.

For graphic presentation of the movements of these highs and lows see Charts I and II.—*Geo. E. Hunt, Chief Clerk Forecast Division.*

RIVERS AND FLOODS.

The upper Mississippi River was frozen over from Hannibal, Mo., northward at the end of the month, the dates of closing varying from the 3d, at St. Paul, Minn., to the 17th, at Keokuk, Iowa. On the 14th the usual winter gorge formed at the Wabash bridge, Hannibal, Mo., and on the 16th the river was blocked for a single day at Grafton, Ill. At Chester, Ill., it was blocked from the 18th to the 26th, inclusive. On the latter date, the U. S. S. *King* broke the gorge. Back of the city of Cairo, Ill., the river froze on the 19th and did not open again until the 26th.

At the end of November, 1901, running ice had been observed as far south as Dubuque, Iowa. It first appeared at Davenport, Iowa, on the 9th of December, and by the 20th had reached Memphis, Tenn., where, from the 20th to the 23d, inclusive, it was present in such quantities as to seriously interfere with navigation. The ice reached Arkansas City, Ark., in large quantities on the 23d, but none was reported at Greenville, Miss., the next station below.

The Red River of the North closed at Moorhead, Minn., on the 2d. In the Missouri River ice was first reported at Sioux City, Iowa, on the 5th, and navigation was closed on the 17th. At Omaha, Nebr., the river was first frozen over on the 13th.

Ice was first observed at Kansas City, Mo., on the 15th, and at Hermann, Mo., on the 14th. At the latter place the river was gorged on the 19th and remained so at the end of the month. In the Illinois River navigation was closed on the 16th on account of ice and extremely cold weather. From the 19th to the 27th the Allegheny River, in the vicinity of Pittsburg, Pa., brought down some ice, as did also the Monongahela on the 21st and 22d. On the Ohio River thin ice was first observed at Cairo, Ill., on the 16th, and above Cincinnati in larger quantities after the 18th. The Arkansas River, at Webbers Falls, Ind. T., was frozen over from the 15th to the 20th, inclusive, and at Little Rock, Ark., from the 19th to the 22d, the earliest closing on record at the latter place. The White River at Newport, Ark., was also closed by ice from the 20th to the 25th, inclusive. Floating ice was reported in the Red River at Arthur, Tex., on the 16th, 17th, and 18th.

In the Susquehanna River, at Harrisburg, Pa., light ice was running on the 20th, and in the West Branch, at Williamsport, Pa., on the 11th. The Potomac River was also full of running ice on the 20th, and floating ice was observed in the Pedee, Wateree, and Ocmulgee rivers on the 22d and 23d.

At the end of the month there were 17 inches of ice in the Mississippi River at St. Paul, 13 inches at Dubuque, and 6 inches at Hannibal. In the Red River of the North, at Moorhead, there were 17 inches; in the Missouri River at Bismarck, N. Dak., there were 12 inches, and at Omaha, 8.5 inches.

As was to be expected during a cold month with considerable ice, the stages of the Mississippi system north of the mouth of the Ohio were lower than during the preceding month. In the Ohio and tributaries, and the rivers of the Atlantic and east Gulf States, conditions were different, owing to the heavy rains about the middle and near the end of the month. There was a moderate flood in the Ohio, beginning in the tributaries, and at Pittsburg, on the 14th. The highest water reported on this rise was 39.5 feet at Cincinnati, and its crest passed Cairo on the 24th at 27.6 feet. No warnings were necessary except in the vicinity of Pittsburg, where the crest stage on the 16th, 25.8 feet, or 3.8 feet above the danger line, was sufficiently high to cause considerable trouble. The following report of this flood was prepared by Mr. Frank Ridgway, the Official in Charge of the Weather Bureau office at Pittsburg.

The weather map of the 14th instant indicated a disturbance over the South and Middle Atlantic States of the character that is almost invariably followed by heavy rainfalls throughout the Allegheny and Monongahela valleys, such rainfalls sometimes causing floods in this section. This storm proved to be no exception to the general rule, and owing to the fact that rain fell steadily in Pittsburg during the forenoon of the 14th, I directed all river observers to send me special river reports at 4 and 8 p. m. When the 4 p. m. reports arrived they showed an average rainfall of over 1.22 inches over both valleys since 8 a. m., and the specials at 8 p. m. showed an average rainfall of 1.55 inches since 8 a. m. About 8 p. m. the rain turned to snow, and I immediately began sending out preliminary advices to all interests affected by flood stages in this locality, that preparations should at once be made for a flood stage by Sunday evening, December, 15, in the three rivers at Pittsburg. I also had this information thoroughly advertised in the morning papers, as many persons would not be at their places of business on Sunday, and would therefore not receive personal notice. Through these notices and the newspaper warnings all interested parties were advised to keep in touch with this office during the day.

The regular Sunday morning river reports showed an average rainfall over both valleys of about 2 inches, ordinarily indicating a stage of 30 to 35 feet at Pittsburg by Sunday night or Monday morning; but, owing to the advance of the cold wave from the west which was already beginning to be felt, it was at once evident that the flow of water would be checked to some extent by the freezing up of the smaller tributaries of the Allegheny and Monongahela rivers, and that consequently a stage of more than 25 feet could not be expected.

The highest stage and most disastrous flood that ever visited Pittsburg occurred February 6, 1884, when a stage of 33.3 feet was reached.

As a definite supplement to the preliminary advices of Saturday night, at 9 a. m. Sunday the police departments of Allegheny and Pittsburg, were notified that a flood stage could positively be expected by Sunday

night or early Monday morning, and immediately thereafter all river observers were telegraphed to furnish hourly special river reports until 4 p. m. Very few of the observers, however, did so for the reason that many of the telegraph offices were closed on that day, and the messages of instruction were therefore not delivered.

The Monongahela River, owing to its more southerly course, was putting out the most water during the day, the water at Pittsburg rising from 0.8 to 1.0 foot an hour until about 5 p. m. The Allegheny River rose from 0.6 to 0.9 foot an hour, and although it was believed that because of the low temperature the highest stage would be reached about midnight, yet it was surprising to note at 10 p. m. that the rivers were still rising at the rate of 0.5 foot an hour. All the various waiting interests were then notified that the highest stage would not exceed 26 feet. This completed the work of warning and the office was closed at 2 a. m. Monday.

The following are the maximum stages reached:

Monongahela River, 25.8 feet, at Pittsburg, 7:30 a. m., Monday, the 15th.

Allegheny River, at Herrs Island Dam, Twenty-second street, Pittsburg, 28.0 feet, at 5:30 a. m. same date.

Upper Ohio River, 24.3 feet, at Davis Island Dam, at 5 a. m. same date.

The warnings issued from this office enabled all business interests receiving them to transfer their movable property, stored in low cellars and warehouses, to places of safety, this movement alone no doubt involving property valued at millions of dollars. In addition, the river and coal operators were enabled to secure their craft and other vast interests in such a manner as to insure their preservation.

The stages in the tributaries of the Ohio on this rise, while decided, were not at all dangerous, and were well covered by timely warnings.

The heavy rains of the month also extended through the Atlantic States, and all the rivers speedily reached flood stages. The Susquehanna was from 4 to 10 feet above the danger line, with a maximum stage of 24 feet at Wilkesbarre, Pa., and of 21.4 feet at Harrisburg, Pa., the highest recorded stage for the month of December. Much damage resulted, particularly in the vicinity of Binghamton, N. Y., where the Chenango River rose to 20.4 feet, the highest stage since 1865, and materially assisted the work of overflow. The Lehigh and Delaware rivers rose far beyond ordinary flood lines, and an immense amount of damage and great delay were caused by overflows and washouts. The Hudson River was also at moderately high stage on the 15th, reaching at Albany, N. Y., 13.1 feet above the low water plane of 1876. Merchants were notified to remove property from cellars and low places, and no damage of consequence resulted.

Mr. E. R. Demain, the Official in Charge of the Weather Bureau office at Harrisburg, Pa., contributes the the following account of the Susquehanna flood within the State of Pennsylvania:

As regards the Susquehanna River system in general, and at Harrisburg, Pa., in particular, the flood of December 15, 16, and 17, 1901, was the most remarkable ever recorded in at least two particulars; the water reached the highest stage ever registered in December, and the rapidity of the rise was, perhaps, the greatest ever known.

Light rains fell at intervals on the 14th amounting to but 0.02 of an inch up to 2:30 p. m.; light rain began at 4:27 p. m., became heavy about 10 p. m. and continued till about 2:50 a. m. December 15; total amount of rainfall at Harrisburg, 1.20 inches. At midnight of the 14th the river registered 5.11 feet on the gage at the pumping station of the city water works, and at 2:30 p. m. of the 15th had risen to 13.9 feet. Reports of heavy rainfalls and high waters at Towanda and Lockhaven, Pa., which came early in the afternoon of the 15th, taken in connection with the swollen condition of the river at Harrisburg, indicated that a serious flood was imminent and at 2:30 p. m. the following warning was issued:

"The Susquehanna River has risen 8 feet at Harrisburg since midnight of the 14th; it was 13.9 feet at 2:30 p. m. to-day and rising about 10 inches an hour. The indications are that it will reach the danger line to-night and probably rise to 18 feet or above to-morrow."

At 6 p. m. the river observer at Wilkesbarre, Pa., reported the river at 24 feet, and the whole Wyoming Valley flooded.

The river at Harrisburg continued to rise rapidly; at 5 p. m. it registered 15.8 feet, and the danger line, 17 feet, was passed shortly before 7 p. m.; the highest point, 21.4 feet, was reached about 2 a. m. of the 16th, the river remaining stationary at that stage till about 6 a. m., when it began to recede slowly, but continued above the danger line till about noon of the 17th. By 8 a. m. of the 18th it had fallen to 14.2 feet.

It is difficult to account for the suddenness and magnitude of this extraordinary flood. Under ordinary circumstances the rainfalls reported would have caused a moderate flood of about 10 feet. The mild weather of the 13th to the 15th doubtless opened all the small tributaries which had been ice-bound, and caused the melting of all the snow within the basin of the Susquehanna, but so far as could be ascertained the quantity of snow was not great, and it is not believed these two factors combined would have carried the flood wave above 12 feet. The only explanation that can be offered for this sudden rise is that the rainfall over most of the Susquehanna watershed, more particularly that drained by the North Branch and especially on the main river within 50 or 60 miles above Harrisburg, must have been very much heavier than at Harrisburg or the stations from which telegraphic reports were received.

Considerable damage was done to property in south Harrisburg, Lochiel, and Steelton, Pa., the water submerging many streets, filling cellars, and in some cases covering the first floors of buildings. The fires in many industrial establishments were extinguished and operations in some were impeded to such an extent as to compel the managers to close them down. The floods caused no loss of life in this vicinity.

The greatest damage was perhaps done at Wilkesbarre, where the river is reported to have reached 24 feet, 10 feet above the danger line, 0.7 foot higher than on March 11, 1893, and the highest point registered since the flood of 1865. Mines were flooded and many houses on the lowlands suffered, in some cases the water reaching a point 4 feet above the first floor. Some of the occupants were removed during the night in boats, while many remained in their houses until morning. The concrete bridges erected during the past year at a cost of \$60,000 for the purpose of providing a means of escape from the houses on the lowlands during times of high water were of no service, as the water covered them completely.

Reports of damage came from all points along the river and its principal tributaries, and the total loss of property was enormous. More damage appears to have been done on the North Branch than on the West Branch or on the Juniata River; at Williamsport, Pa., the highest stage reached was but 0.7 foot above the danger line, while at Lockhaven the maximum stage reported was only 7 feet.

Two lives were reported lost in the flood on the North Branch in Luzerne County; one near Hazleton, Pa., and the other in Nanticoke, Pa.

Following are the greatest December floods on record at Harrisburg: December 12, 1878, 18.5 feet; December 29, 1881, 11 feet; December 19, 1888, 11.5 feet; December 16, 1901, 21.4 feet.

The Potomac River above Washington rose a few feet above the nominal danger line, but no damage was reported.

The rise in the James River was comparatively moderate, a stage of 0.8 foot above the danger line, 12 feet, being reached on the 17th. Local warnings were issued on the 16th, and, in consequence, all portable property liable to overflow at a 13.5 foot stage was removed to places of safety.

The upper portion of the Santee River system was at ordinary flood stage at the same time. The rise was forecast in due season and was without unusual feature.

The floods of the closing days of the month were much more pronounced, except in the extreme upper Ohio River, and were attended by much more serious consequences. They began in the tributaries of the Ohio River on the 29th, and the crest had not progressed very far beyond Wheeling, W. Va., on the 31st. New River was in flood for the fifth time during the year, an occurrence never before known. At Charleston, W. Va., the Great Kanawha River reached a stage of 38.5 feet on the 20th, or 8.5 feet above the danger line. Great damage was done; in fact, from all river valleys on both sides of the mountains came reports of unusually high water, washouts, wrecks, overflows, breaking of dams, flooding of manufactories, loss of livestock, etc. The total damage amounted to many millions of dollars, nearly all of which was absolutely unavoidable. Flood warnings were issued promptly and generally, and the loss of additional millions thereby prevented. The flood in the upper Tennessee River is thus described by Mr. L. M. Pindell, Official in Charge of the United States Weather Bureau office at Chattanooga, Tenn.

The river fell slowly after the 20th, becoming stationary by the 24th, when light rain fell over the system, continuing at intervals, until the 28th, saturating the ground and producing a slow rise in the river. On the morning of the 27th, an average of over two inches of rain had fallen over the headwaters during the previous twenty-four hours, producing a rise of 8 feet at Clinton, Tenn., 5 feet at Kingston, Tenn., 7 feet

at Knoxville, Tenn., and nearly an 18-foot rise at Speers Ferry, Va., with the river one foot below the danger line. The following forecast was then issued: "The river and tributaries will rise rapidly. About a 17-foot stage will occur at Knoxville, Tenn., Saturday, and a 24-foot stage at Chattanooga, Tenn., Saturday night." At 8 a. m., Sunday the 29th, the stage at Chattanooga, Tenn., was 24 feet, and 17.2 feet at Knoxville, Tenn. The information as to Chattanooga's expected stage was telegraphed to the observer, Cairo, Ill. The following message was telephoned to Kingston, Tenn.: "Clinch River rising rapidly at Clinton and Speers Ferry. Heavy rain above your station. The river will rise rapidly, reaching about 20 feet at your station, Saturday night." The stage at Kingston, Tenn., at 8 a. m., Sunday morning, was 18.6 feet. The morning river reports on the 29th disclosed additional heavy rains, averaging over 2½ inches over the system, between 8 a. m. of the 28th and 8 a. m. of the 29th, with rain still falling. As the river was already at a moderately high stage, this indicated a general rise attended with more or less danger to property. Flood warnings were issued at once. The following message was telephoned to Kingston, Tenn.: "River 3½ feet above danger line at Clinton and rising. Heavy rain over entire headwaters. River will reach and probably pass danger line at your station Monday. Warn public."

The observer at Knoxville, Tenn., was notified that over two and one-half inches of rain had fallen above his station and that the river would rise rapidly. The observer at Cairo, Ill., was informed as to rainfall above, and that the river would pass the danger line at Chattanooga, Tenn., by noon Monday. Postmasters and various business interests at many places received the following flood warning: "Heavy rainfall above. River and tributaries rising rapidly. River will pass danger line at Chattanooga Monday. Warn public." The following summary was furnished the press: "The river will pass the danger line at Chattanooga, Tenn., by noon Monday. The crest can not be estimated at this time as rain was still falling over the entire system when the last reports were received. Flood warnings have been sent to Knoxville and Kingston, Tenn., and over the lower river as far as Cairo, Ill. The river will continue to rise Monday and Tuesday. As the ground is already full of water all the rainfall will find its way into the river channel and help to augment the tide." The 8 a. m. reports of December 30th, (Monday) gave almost 11 feet of rise at Charleston, Tenn., over 12 feet at Knoxville, Tenn., and 8 feet at Kingston, Tenn., and Chattanooga, Tenn., with the river above the danger line at every station above and within one foot of it at Chattanooga, Tenn. At 10 a. m. the Chattanooga stage was 32.7 feet; at 3 p. m. 34 feet, and at 6:40 p. m. 34.9 feet. The following forecast was made and extensively issued, the Associated Press assisting in its dissemination: "The river will continue to rise to-night and Tuesday, reaching a stage between 40 and 42 feet by midnight Tuesday."

The observer at Cairo, Ill., was also notified of the conditions over the system and the expected stage at Chattanooga. The 3 p. m. reports of the 30th showed a slight fall at Charleston, Tenn., and Speers Ferry, Va., and rises at all other points, and the following note was entered on the p. m. bulletins: "No change made in forecast issued this morning. The rise will be slow for the next thirty hours." The morning reports of the 31st showed a slight fall at Loudon, Tenn., stationary at Knoxville, Tenn., falling at Charleston and Speers Ferry and still rising at Kingston and Clinton, Tenn. The following forecast was issued: "The river will rise slowly till about noon of Wednesday; it will reach the 40-foot mark about 11 o'clock to-night, and the crest will be between 41 and 42 feet."

Special readings were made during the day as follows: 9 a. m., 37.7 feet; 10 a. m., 37.9 feet; 3 p. m., 38.6 feet; 5 p. m., 38.8 feet; 7 p. m., 39.0 feet; 8 p. m., 39.2 feet; 9 p. m., 39.3 feet; 10 p. m., 39.4 feet, and 11 p. m., 39.5 feet. The month closed with the river rising steadily and with the highest river on record for the month of December by 13 feet and over. Light drift began passing this station in the afternoon of the 27th, became moderately heavy in the afternoon of the 28th, and was heavy all day of the 29th, 30th, and 31st. It consisted of logs, fences, outhouses, haystacks, trees, and trash. The high tide over the headwaters affected the railroads, causing the Southern Railway to annul all trains between Knoxville, Tenn., and Asheville, N. C., the water covering the tracks between Newport and Rankin, Tenn. All the factories and mills under the 40-foot mark and merchants whose cellars were below the 40-foot mark had from 72 to 80 hours warning and took the necessary steps to remove their goods and protect their property. This action was not confined to this city alone, but extended over the entire river valley from Knoxville and Kingston to Cairo. The Nashville, Chattanooga, and St. Louis Railroad branch from Kingston, Tenn., to Rome, Ga., was abandoned on the 30th. Trains were all delayed and compelled to run slowly. Washouts were reported on the Southern Railway at White Pine, N. C. All families, about seventy-five in number, who were below the 41-foot mark were notified to move, which they did before the water reached them; all above the 41-foot mark were instructed to remain. As far as known, not a dollar's worth of property between Knoxville, Tenn., and Cairo, Ill., was lost or damaged that could have been saved.

The flood in the lower Tennessee River from Florence, Ala., to its mouth continued until January 9, 1902, and was thus

reported by Mr. P. H. Smyth, Official in Charge of the United States Weather Bureau office at Cairo, Ill.:

The rise, which was due principally to heavy rainfalls over the upper watershed, set in at Florence, Ala., on the 26th, and reached Johnsonville, Tenn., on the 28th. It crested at Florence on January 6, 1902, at a stage of 21.0 feet, and at Johnsonville on January 9, at a stage of 28.5 feet.

Warnings were sent out well in advance of the flood's crest, and were disseminated by telegraph, telephone, and mail. They were the means of saving considerable property; stock was driven out of the bottoms to places of safety and large quantities of cross-ties on the islands and river banks were removed to high ground or otherwise secured.

This office has learned of no damage which a warning could have averted, and of no material damage resulting from the high stages.

The warnings were taken advantage of in other ways besides protecting property in danger. The head of a lumber firm located in a nearby town informs this office, that his firm got out about 150,000 feet of logs on the rise.

Mr. B. Bruce of Savannah, Tenn., in a communication to this office regarding the information furnished him, expresses himself as follows: "The information received from your office is of much importance to the general public in this section. I have telephone connection with all parts of this entire section, and keep all posted in regard to sudden rises in the rivers. The information received during this last rise was the means of saving a great deal of stock and other property. Few knew of its coming until I sent out notice."

The very accurate information telegraphed to this office by the official in charge of the Weather Bureau office at Chattanooga, Tenn., relative to existing and prospective conditions in the upper river was of much interest and value to persons in this section who have interests along the Tennessee River.

The flood in the James River Valley was one of the most extensive ever experienced in that section, the stages ranging from 3 feet above the danger line at Lynchburg to 11.2 feet above at Richmond. The crest stages were well forecast, and were very timely. Mr. E. A. Evans, the Official in Charge of the Weather Bureau office at Richmond, sends the following account:

One of the most extensive and threatening floods, in all its aspects, that has ever occurred in the James River Valley since records have been kept was a result of a period of precipitation beginning at 4 p. m. Saturday, December 28, and ending during the early morning of Monday the 30th. It was general over the whole watershed and the amounts deposited were heavy, particularly in the Appalachian and Blue Ridge portions of the basin, where they ranged from 2.50 to 4.28 inches. The effect of these conditions was emphasized by the preceding cold and wet condition of the ground, so that there was nothing to prevent a maximum run-off from reaching the drainage tributaries and the main stream. During Sunday forenoon, telegrams began coming in from the special river and rainfall stations; flood-warning messages were issued for upper river points and advisory warnings locally, as detailed in the latter part of this report.

As anticipated, the river began rising during Sunday night, and the next morning had reached 12.2 feet on the gage and was still rising. Throughout the day it rose steadily at the rate of about 0.4 foot an hour, and it early became evident that a serious flood was impending. In the early morning additional special telegrams were received from Lynchburg, Charlottesville, and Buena Vista, Va. At Columbia, Va., the key to the local situation, the telegraph wires went down early in the forenoon. Prompt steps were taken, however, to advise local interests of the probable conditions that would occur during the afternoon and night.

By 11 a. m. the wharfs of the Virginia Navigation Company, the Clyde Line, and the Baltimore Steam Packet Company were under water, and in the early afternoon the fast rising tide had entered Lester street, cutting off street car communication between this city and the suburb of Fulton. The lower floors of houses in the neighborhood were flooded, and the residents driven up into the second stories. As night came on the flood had increased sufficiently to get into the lower business portions of the city, and Main street, near Seventeenth, soon became impassable, street car traffic was interrupted and all business houses in the vicinity were forced to close their doors.

The morning of Tuesday, December 31, found a section of the city, embracing a large number of retail stores and the butcher and huckster stands in the Old Market, under water varying in depth from 1 to 6 feet. At noon the official in charge went over the flooded area in a boat. The conditions really beggared description. Imagine a body of water about 900 feet wide, and deep enough to traverse in a boat, running directly through the business portion of the lower part of the city, and extending from the river proper inland about half a mile; and not only this, but the entire water front from one to three blocks back from the river, and extending from Fifteenth street to Fulton, or over a mile, covered with 4 to 8 feet of muddy water. Within this whole area not a wheel

was turning in any manufacturing establishment, the shipyards were flooded and all lines of wholesale and retail business were completely paralyzed. A large quantity of lime stored in the plant of Warner, Moore & Co. began to slack as soon as reached by the flood, setting fire to the building. During the afternoon the waters continued to rise until about 4 p. m., when the gage read 23.2 feet, the highest since June, 1889, when 25 feet was had. At this point it remained practically stationary for an hour and then began to fall slowly. Long before this, however, the city gas plants had been flooded, the furnaces quenched and workmen driven out. The city was without gas Tuesday and Wednesday nights, and manufacturing establishments, newspaper plants, etc., using gas for fuel were crippled.

The nights of December 30-31 and January 1 will long be remembered by many of the citizens living in the vicinity of lower Fulton and Gillies Creek. In these suburbs the waters rose to such a height, and at one time so rapidly, that a number of families were forced to flee for their lives, and eventually several hundred were rendered temporarily homeless. A portion of the water front of the neighboring town of Manchester, on the opposite side of the river, also suffered in the same way, though not to so great an extent, about fifty families being reported as driven from their homes. As above noted the recession of the waters began about 5 p. m. of December 31, but it was not until the night of January 1 that the streets of the city in the flooded area again became clear of water and open to traffic.

Compared with preceding notable floods the present one is surpassed in respect to maximum stages reached by those occurring in the years 1870, 1877, 1886 (April), and 1889 (June), by from 1.1 to 5.4 feet; yet, when the magnitude of the interests jeopardized by it are considered, it may fairly be held to stand at the head of the list in importance.

The following shows the flood forecasts issued and the steps taken for their dissemination, together with the gage readings, regular and special, made:

By 1:30 p. m. Sunday, December 29, sufficient data was at hand to justify the issue of preliminary warnings locally. A stage of about 12 feet by 8 a. m., Monday was forecast. At 4 p. m. Sunday flood forecasts were wired to upper river points comprising Lynchburg, Norwood, and Scottsville, Va.

At 10 a. m. Monday the maximum height for the day, locally, was placed at 18 feet, and at noon a messenger was sent through the city district threatened to make a house to house distribution of the warning and advise the removal of goods. The telephone was also freely used in warning special industries and in sending out general information to public and press. At 11 p. m. Monday, in consequence of the general uneasiness induced by wild rumors afloat, it was deemed best to issue a statement that would be as positive, yet as conservative, as the case would allow, and accordingly the last forecast of the flood was made and distributed, viz:

"The maximum flood height will probably not exceed 24 feet, occurring to-morrow;" and on the following morning, Tuesday, by phone and note on weather map, "The maximum flood height will occur to-day and will probably not exceed 24 feet."

Gage readings taken were as follows:

December 30.—8 a. m., 12.2 feet; noon, 13.9 feet; 2 p. m., 14.5 feet; 3:15 p. m., 15.1 feet; 5 p. m., 15.9 feet; 11:30 p. m., 19.0 feet.

December 31.—3 a. m., 20.5 feet; 4 a. m., 21.0 feet; 8 a. m., 21.9 feet; noon, 22.5 feet; 1 p. m., 22.5 feet; 3 p. m., 22.9 feet; 4 p. m., 23.2 feet; 5 p. m., 23.0 feet; 10 p. m., 21.8 feet.

January 1.—8 a. m., 20.5 feet, and 11:30 a. m., 18.9 feet. This was the last of the special readings taken.

While the damage done by the flood was considerable, amounting to thousands of dollars, not including the losses experienced from the enforced suspension of business, yet it was for the most part unavoidable and was not in any way due to want of prompt and effective distribution of warnings or of time for proper preparation. In all cases the Bureau sent out warnings twelve to eighteen hours in advance of the arrival of the predicted conditions.

The North Carolina rivers did not rise much above the danger lines, and a warning of moderately high stages, only, was issued on the 30th.

More rain fell over South Carolina, and the rivers were proportionately higher. Warnings of dangerous stages over the Santee system were issued promptly, and were fully justified by subsequent events. The conditions prevailing at the time are thus described by Mr. L. N. Jesunofsky, Official in Charge of the Weather Bureau office at Charleston, S. C.:

Almost continuous rainfall at Gaffney, S. C., on the upper Broad River, and at Salisbury, N. C., on the upper Pedee River, from the 27th to the 31st, measuring 4.65 inches and 4.38 inches, respectively, effected a rise of 23.5 feet at Camden, S. C., 28.2 feet at Cheraw, S. C., and 20.3 feet at Columbia, S. C., during the 28th to 31st. The Wateree River at Camden, S. C., reached the danger line, 24 feet, at 8:30 a. m. of the 29th. The point of danger, 27 feet, at Cheraw, S. C., was reached at 5 a. m. of the 30th. The Congaree River at Columbia, S. C., reached the point of danger, 15 feet, at 1 p. m. of the 29th. At the end of the month the

waters at Camden, Cheraw, and Columbia, S. C., were 6.0 feet above danger points and rising at the rate of 3.0 feet a day. The freshets within the three last-mentioned streams were due to reach Smiths Mills, on the lower Pedee River, and St. Stephens, on the Santee River, on January 7, 1902, as forecast. Driftwood, including a large amount of cut timber, was running heavily on the Wateree, Pedee, Congaree, Saluda, and Broad rivers during the 29th, 30th, and 31st.

The heavy rains, which began in the upper drainage areas late on the 27th and continued with but few hours' intermission to the 31st, wrought considerable damage throughout the upper counties in South Carolina. The Reedy River, a branch of the Saluda River, near Greenville, S. C., was far out of its banks. Quite a number of bridges were washed away and the roads were almost impassable until January 1. Trains in that section were running far behind their scheduled time, and the roadbeds were considerably damaged. The Yadkin River, in North Carolina, an upper tributary of the Great Pedee River, was 30 feet above the common water level on the afternoon of the 30th. A part of the dam of the Anderson Water, Light, and Power Company, located at Portman Shoals, 10 miles west of Anderson, was washed away on the night of the 29th, entailing a loss of about \$75,000. Several cotton mills were compelled to shut down on account of the loss of water power. It is thought by some that the numerous drifting logs and rafts were the chief cause of breaking the dam.

The flood in the Chattahoochee River was rapid, extensive, and exceedingly destructive. It was forecast as well and accurately as was possible under existing conditions, and the warnings were especially timely near and below Westpoint, Ga. The report on this flood was prepared by Mr. J. B. Marbury, Official in Charge of the Weather Bureau office at Atlanta, Ga:

The abnormally heavy rains which fell over the upper portion of the drainage area of the Chattahoochee River during the last day or two of the month caused severe floods at nearly all points along its course. Up to the 28th low water prevailed. Rain began during the early morning of the 28th and continued with periods of excessive falls until the 29th. As a result the following abnormal rises occurred: Oakdale, Ga., 29th, gage reading 22.0 feet, a rise of 16.9 feet in 24 hours; 30th, 27.0 feet, rise of 5.0 feet in 24 hours; Westpoint, Ga., 29th, gage reading 19.0 feet, a rise in 24 hours of 12.2 feet; rainfall for preceding 24 hours, 7.30 inches; 30th, gage reading 25.0 feet, a rise of 6.0 feet. Eufaula, Ala.: the crest of the flood did not reach this point till the 31st as is shown by the following gage readings: December 28, 6.7 feet, a rise of 1.4 feet, due to moderate rains on the three preceding days; December 29, gage reading 11.7 feet, a rise of 5.0 feet; December 30, gage reading 31.6 feet, a rise of 19.9 feet; December 31, gage reading 41.0 feet, a rise of 9.4 feet.

Warnings sent from this office on the morning of the 29th to Westpoint and Columbus, Ga., Eufaula, Ala., and Bainbridge, Ga., stating that the danger line would be passed at each of these points, were fully verified, and were received in ample time to allow the saving of considerable property at points below Westpoint, Ga. The latter place was warned that the water would reach 25.0 feet during Monday morning, and as shown by the above figures the warning was fully verified. Columbus, Ga., was communicated with several times by telephone and the information given was of much value to the city.

At Westpoint, Ga., three persons were drowned and railroad communication was shut off for one or two days. Many damaging washouts were reported along the line of the Atlanta and Westpoint Railroad. Several bridges were washed away near that city and the business section of the city was under water for two days.

At Columbus, Ga., the water passed the danger line and part of the mammoth dam of the Columbus Power Company was swept away. Great piles of drift wood, trees, &c., landed against the highway bridge leading across to Alabama, and it was with great difficulty that the structure was saved. The power house of the Columbus Electric and Railroad Company was flooded and the town was in darkness. During the 31st the water at Columbus, Ga., receded several feet so that the electric and street railway plants were able to resume operations. No lives were lost, and no damages were reported from other points.

The rivers of southeastern Georgia were not abnormally high.

The floods over the Alabama system were also extensive, and equally well anticipated by Mr. F. P. Chaffee, the Official in Charge of the Weather Bureau office at Montgomery, Ala., Mr. Chaffee's record of the flood is as follows:

A heavy rainfall having been reported at Canton, Ga., on the morning of December 28, 1901, and the weather conditions being such as to presage further heavy rains over the watersheds of this river district, warnings were telegraphed to Rome, Ga., and Gadsden, Ala., advising

that the upper Coosa River would rise rapidly; special reports were also called for from all river stations for the following morning (Sunday). The morning reports of the 29th showed the following 24-hour rainfalls:

Canton, Ga., 4.55; Resaca, Ga., 3.45; Rome, Ga., 3.64; Gadsden, Ala., 2.70; Wetumpka, Ala., 4.80; Tallassee, Ala., 7.59; Montgomery, Ala., 5.04; Selma, Ala., 3.10. At 10 a. m. warnings were telegraphed the different river stations that the following stages would be reached: Tallassee, Ala., 22 feet during night of 29th; Canton, Ga., and Resaca, Ga., moderate flood stages; Rome, Ga., 32, and Gadsden, Ala., 23 feet by night of 30th; Lincoln, Ala., 20 feet by morning of 31st; Wetumpka, Ala., 37 feet by night of 31st; Montgomery, Ala., about 34 feet by morning of January 1, and Selma, Ala., 35 or 36 feet by night of 1st or morning of 2d. Advice was also given that stock should be moved to high ground and other necessary flood precautions taken along the entire Coosa and Alabama rivers.

During the 30th special reports were called for from substations at 10 a. m., 12 noon, and 2 p. m., and in subsequent supplemental warnings the expected stages were raised to the following: Rome, Ga., 33 feet; Gadsden, Ala., 26; Lincoln, Ala., 22; Wetumpka, Ala., 49; Montgomery, Ala., 48; Selma, Ala., 50. Later, however, those interested were advised that the following stages would not be exceeded: Gadsden, Ala., 24 feet; Wetumpka and Montgomery, Ala., about 47, and Selma, Ala., about 47.5 feet.

During the entire rise the rivers were watched very closely, special reports being called for as needed and hourly readings of the river gage made at Montgomery, Ala., during a part of the time. Every effort was made to promptly notify those interested of the progress of the flood, and to relieve anxiety by definite information and warning. The absence of reports from Tallassee, Ala., on account of wire trouble, at the most critical period of the flood greatly hampered calculations on the stages in the lower Coosa and upper Alabama rivers, which were made even more difficult by the breaking of a large dam above Tallassee, Ala. However, the warnings were, on the whole, quite satisfactory, as was shown by the very commendatory press notices and by letters from persons in communities which were directly benefited. Considerable damage was done which no warning could avert, being mostly to mill property, public bridges, lumbering interests, and in the way of washouts of railroad embankments. On the strength of the warnings, several of the railroads centering here had repair trains in readiness to protect their roadbeds.

While it is difficult to approximate the value of the warnings, it is thought that about \$200,000 worth of property was jeopardized by the high waters, the most of which was saved by the warnings. One of the most gratifying phases of the matter was the general confidence shown in the warnings, and the fact that the different interests affected by sudden river rises in this region appreciate the necessity for immediate protective measures when flood warnings are issued.

The flood crest passed Rome, Ga., during the morning of the 31st, Montgomery, Ala., about 6 p. m. of the 1st, and Selma, Ala., during afternoon of the 3d.

Recapitulation.—Total rainfall December 28–29th:

	Inches.
Canton, Ga.....	6.33
Resaca, Ga.....	3.50
Rome, Ga.....	3.81
Gadsden, Ala.....	2.82
Lincoln, (Lock 4), Ala.....	3.13
Tallassee, Ala.....	7.88
Wetumpka, Ala.....	4.90
Montgomery, Ala.....	5.10
Selma, Ala.....	3.10

Stations.	River stages.				
	Danger line.	8 a. m., 28th.	Total rise.	Highest reached.	Stage forecast.
	Feet.	Feet.	Feet.	Feet.	
Canton, Ga.....	20	3.6	17.4	21.0	Moderate flood.
Resaca, Ga.....	23	10.2	16.6	26.8	About 26 feet.
Rome, Ga.....	30	6.0	26.6	32.6	About 33 feet.
Gadsden, Ala.....	18	7.5	16.1	23.6	About 26 feet.
Tallassee, Ala.....	23	1.1	19.5	20.6	About 22 feet.
Wetumpka, Ala.....	45	8.7	37.8	46.5	About 47 feet.
Montgomery, Ala.....	35	5.5	41.3	46.8	About 47 feet.
Selma, Ala.....	35	6.0	41.0	47.0	About 47.5 feet.

The danger line was exceeded by several feet in the Black Warrior and lower Tombigbee rivers. Warnings were issued as usual, and no reports of serious damage have been received.

The rivers of the Pacific coast were higher as a rule, but nothing of special interest was noted.